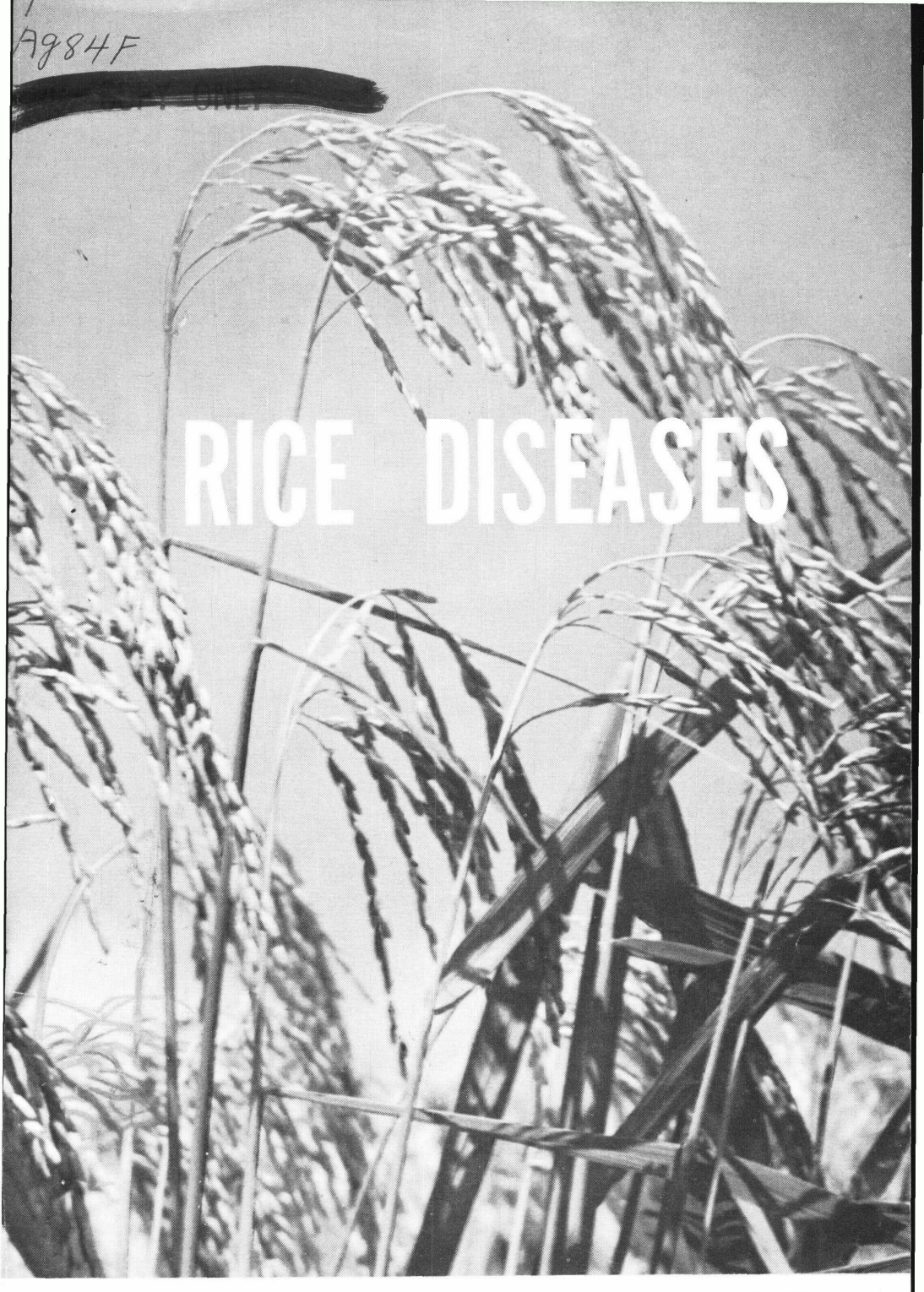

RICE DISEASES

Farmers' Bulletin No. 2120

UNITED STATES DEPARTMENT OF AGRICULTURE

Contents

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RICE DISEASES

By JOHN G. ATKINS, *pathologist, Crops Research Division, Agricultural Research Service*

Southern rice growers lose a substantial part of their crop every year because of rice diseases. In the four leading rice-producing States of the South—Texas, Louisiana, Arkansas, and Mississippi—diseases reduce the average annual yield by about 5 percent. This means an annual loss of more than 100,000 tons of the grain. Similar percentages of the annual yield are lost through disease in States that grow rice on smaller acreages, including Missouri, Florida, and South Carolina. In California, where much rice is grown, natural conditions are so favorable to this crop that its diseases have very little effect on farm income.

This bulletin discusses each of the eight principal diseases affecting rice in the South. It tells how losses from these diseases can be reduced through choice of varieties to grow, seed treatment, methods of growing the crop, and correctly timed flooding and draining of ricefields. It gives some information also on rice diseases that cause minor losses in these States. At the end of the bulletin, table 1 lists the scientific names of organisms causing diseases and summarizes the recommended control measures and table 2 classifies rice varieties with regard to disease resistance and susceptibility.

Principal Rice Diseases

Seedling Blight

Seedling blight causes stands of rice to be spotty, irregular, and thin from the time they are established. It results from the activities of various kinds of fungi, most of which grow on the kernels or hulls of seed rice or on soil particles. These fungi enter the germinating rice seed or the young seedling and either kill or injure it. If blighted seedlings emerge from the soil at all, they are likely to die soon thereafter. Those that survive are generally weak and yellowish. Figure 1 shows seedlings affected with blight in contrast with one that is normal.

How widespread and severe blight becomes in a field of rice depends chiefly on three things: (1) What percentage of the seed are infested by blight fungi; (2) the soil temperatures; and (3) the soil's moisture content. Seedling blight is more severe on rice that has been seeded early, when the soil was cool and damp. (In Texas and Louisiana, the early seeding season is late February and March.) This disadvantage of early seeding can be partly overcome by planting at a shallow depth. Conditions that tend to delay the seedlings' emer-

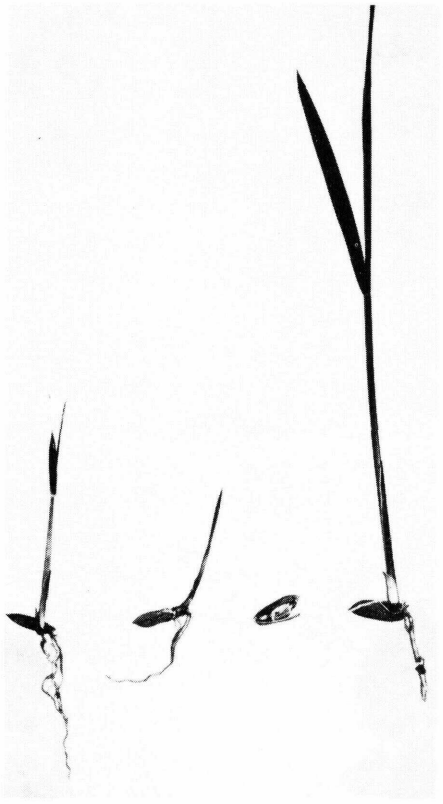

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Figure 1.—**Three blighted rice seedlings and, at right, a healthy one.**

gence from the soil often favor seedling blight.

Seed that carry blight fungi frequently show spots or discolorations on their hulls. However, seed can be infested and still appear to be clean.

The fungus that causes brown leaf spot (discussed later) also is one of the chief causes of seedling blight. A seedling attacked by this fungus shows dark areas on the basal parts of the first leaf.

Some blights that affect rice seedlings at the time of germination can be controlled by treating the seed with chemicals. In extensive tests on rice seed, these fungicides have given the best results: Arasan SFX, Spergon-SL, Phygon-XL, Agrox, Ceresan 100 and 200, Ceresan M and M2X, MEMA, Panogen 15, and Yellow Cuprocide.[1] Seedling blight caused by the fungus that causes brown leaf spot can be partly controlled by using one of these mercury fungicides: Ceresan M and M2X, Ceresan 100 and 200, Panogen 15, Agrox, and MEMA. Each of the chemicals listed is available in different preparations. In using a fungicide that is sold under a trade name, the rice grower should carefully follow the manufacturer's directions regarding quantity to apply and method of application.

The fungicides listed above are intended primarily for use in the

WARNING

The materials recommended here for treating rice seed should be considered poisonous to man and animals. Care should be taken in handling and using them. Read the label placed on each container by the manufacturer and follow his instructions regarding safety measures. All workmen operating seed-treating equipment should be carefully taught how to use the chemicals and warned against carelessness. Sacks of treated seed should always be properly labeled. Care should be taken to prevent any treated seed from being used as food or feed.

[1] Use of trade names of fungicides in this discussion does not mean that the Department of Agriculture guarantees the standard of products sold under these names. Also, it does not imply that the Department endorses these products as more effective for treating rice seed than any other fungicides.

ordinary commercial type of seed-treating machine—that is, the slurry type. Some of them can be applied to rice seed on the farm in the form of dust.

If rice seed is to be sown early in the season, treating it is likely to mean the difference between getting a satisfactory stand with the first seeding and having to seed a second time. In experiments, seed treatment has sometimes doubled the density of the stand obtained. Little benefit results from treating rice seed that is to be sown late in the season, however, unless unfavorable weather conditions prevail at the time of seeding.

The seed treatments recommended here are particularly suitable for rice sown with a grain drill, but treatment with Yellow Cuprocide has increased the density of stands of water-seeded rice in fields that were not drained after the seeding.

One soilborne blight fungus, *Sclerotium rolfsii*, sometimes kills or severely injures large numbers of rice seedlings after they emerge, if the weather at emergence time is moist and warm. A cottony white mold develops on the lower parts of affected plants. This type of blight can be checked by immediately flooding the land. Seed treatment has little or no value for controlling it.

White Tip

White tip is caused by a nematode, or eelworm, which is too small to be seen without a microscope. The tips of the affected leaves turn white and later become frayed and dark colored. Parts of the leaf other than the tip, also, may show light-colored or white areas. The symptoms become most conspicuous, particularly on the flag leaf (the top leaf), just before heading. Often the flag-leaf blade and sheath are twisted so that the head is held within the boot (fig. 2). Severely affected plants have stunted heads that produce few grains, and these grains often are abnormal in shape.

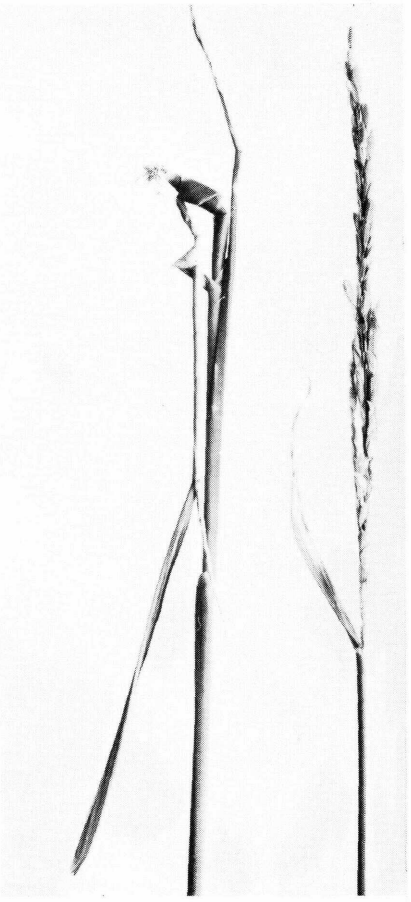

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Figure 2.—**Heads of rice plants affected with white tip.**

The nematodes that cause white tip are carried on the seed and can attack a rice crop wherever the infested seed is sown. These nema-

todes do not live in the soil over the winter. During the growing season they may be carried by floodwater from one field to another. Those found on mature rice seed are either on the inner hull surfaces or on the kernel. None get inside the kernel. The nematodes remain dormant during the months between harvest and seeding. When an infested seed is sown in warm, moist soil the nematodes on it become active, and when the seed has germinated they move into the growing point of the young rice plant. There they feed and rapidly increase in numbers. Their feeding on the young leaf or on the developing head in the boot results in the symptoms described above. At the heading stage the nematodes establish themselves inside the rice flower, and there they remain during the period of grain formation. As the grain matures, they become inactive. Dormant nematodes may remain alive on rough rice in storage for 2 years.

Commercial rice varieties differ greatly in resistance to white tip. The disease can be controlled simply by growing only varieties known to be resistant. In general, long-grain varieties are resistant and short-grain or medium-grain varieties are susceptible. In an area infested with the nematode causing white tip, absence of typical leaf symptoms of the disease is a reasonably dependable sign of resistance, although it is not a sure sign. Seed of known susceptible varieties that is free of white tip nematodes can be obtained from fields that show no signs of infection.

Treating seed rice to eliminate the white tip nematode has resulted in control of the disease in experiments, and certain treatments can be used on small lots to produce seed rice free of the nematode for increase or distribution. However, no treatment for this purpose is recommended at present for general use.

Apparently, a grower who starts with a clean lot of seed can produce 3 to 5 generations of rice fairly free of nematodes if he takes reasonable precautions. The principal precaution needed is to avoid use of irrigation water that has passed through a field infested with nematodes.

White tip has been controlled in Arkansas by seeding in water and then keeping the field flooded.

Straighthead

In straighthead, rice heads remain upright at maturity because the few grains formed are too light to bend them over in the normal manner (fig. 3). The diseased heads often contain no fertile seed. Usually the hulls are distorted into a crescent or "parrot beak" form. This distortion is especially conspicuous in the long-grain varieties. One or both of the hulls may be missing (fig. 4). Other parts of the flower, also, are frequently absent. In severe cases, the heads are much smaller than normal and emerge slowly or incompletely from the boot, or the plants practically fail to head. Affected plants continue to grow, have a green color darker than normal, and frequently produce shoots from the lower nodes.

Apparently straighthead results chiefly from some abnormal soil condition that develops around the roots of the rice plant after several weeks' flooding. In many instances

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Figure 3.—**Straighthead. The rice has matured, but most of the heads contain so few grains that they remain upright.**

it has occurred when the soil contained too much undecayed plant material from lespedeza and other crops that had been plowed under. First-year crops of rice grown on new land are more likely than others to be affected. Straighthead has given trouble frequently on sandy loam soils but very seldom on clay soils. On limited areas, it has been caused by arsenic that has accumulated in the soil as a result of repeated applications of arsenic-containing insecticides to cotton.

Losses in affected fields vary from slight to nearly complete. Generally, straighthead occurs only in spots scattered through a field of rice that is otherwise normal.

No variety of rice is immune or even highly resistant to straighthead. Resistant and moderately resistant varieties include Fortuna, Arkansas Fortuna, Bluebonnet, Bluebonnet 50, Toro, Prelude, Texas Patna, and Lacrosse. Nato, a medium-grain variety, is less susceptible than Zenith, Magnolia, or Arkrose.

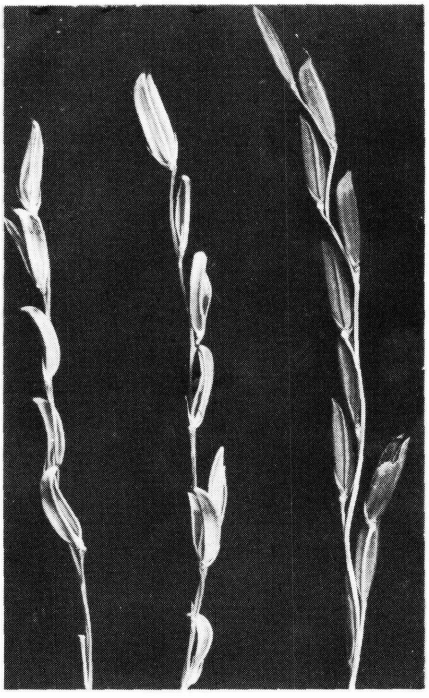

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Figure 4.—Straighthead. The two branches at the left have sterile florets with distorted hulls. The third is normal.

Rexoro, TP–49, and Sunbonnet are very susceptible. On land where rice is known to be subject to straighthead, only the more resistant varieties should be sown.

Rice growers in the Gulf States have controlled straighthead for many years by draining the fields just before growth reaches the shooting stage. In Texas, apparently the right time to drain Century Patna 231, a variety that matures in about 120 days, is about 52 days after the seedlings emerge from the soil.

Brown Leaf Spot

Brown leaf spot is one of the more prevalent and serious rice diseases, particularly in Texas and western Louisiana. The fungus causing it attacks the seedlings and also the leaves and necks of older plants, the hulls, and the kernels. (The word "neck" is applied here to the part of the rice stem just below the head.) The fungus is seedborne. Probably, also, it lives from one crop to the next on old rice straw in the soil.

Leaf spots may be evident from shortly after the seedling emerges until the plant matures. They are circular or oval (fig. 5) and are of a dark-brown or grayish color. The spots vary in size, color, and appearance according to rice variety. Severe leaf spotting is often shown by plants in dense stands and by other weak plants. On severely affected plants the leaves, or large parts of them, die before maturity and the disease may reduce the yield and the quality of the grain.

When the brown leaf spot fungus invades the neck or branches of the head it causes a condition known as rotten neck, which is similar to one caused by blast (the disease discussed next). A plant thus affected has lightweight or chalky kernels. Spots very similar to those on the leaves appear on the hulls and persist after the seed matures. Spots or stained areas may occur also on the kernels, reducing the quality of the grain.

If rice has been protected by seed treatment from seedling blight caused by the fungus that causes brown spot, it can still become infected with this fungus when it has grown beyond the seedling stage.

No rice variety is considered resistant. Damage from brown spot can be lessened by maintaining

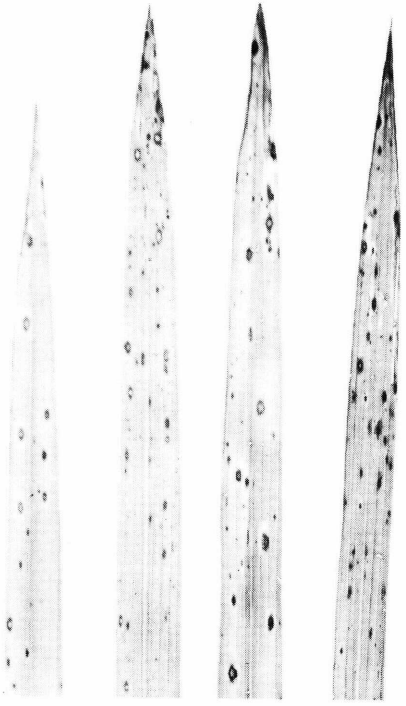

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Figure 5.—Brown leaf spot, one of the most prevalent and serious diseases of rice.

good growing conditions for rice through balanced fertilizing, crop rotation, land leveling, thorough soil preparation, and other good cultural practices.

Blast

Blast (also called rotten neck, brusone, and piricularia blight), although generally of minor importance in the southern rice States, has occasionally caused serious losses there. In Florida it has sometimes done so in combination with other rice diseases.

Blast is a fungus-caused rice disease in which spots appear on the leaves (fig. 6) and blighting of the leaves or of the whole plant follows. Rice plants probably are most susceptible to leaf attack before irrigation begins and at the tillering stage. The spots on young leaves are generally long, rather narrow, and brown with grayish centers. They resemble those of the brown leaf spot disease, and sometimes it is hard to tell the two kinds apart except by using a microscope. Blast differs from brown leaf spot, however, in that it causes longer spots, develops more rapidly, and blights the leaves. In severe cases, the plant is stunted and loses nearly all its leaves or the whole plant (including the tillers) is killed.

The blast fungus frequently attacks the neck, blighting the head. Frequently, also, it attacks branches of the head. The name "rotten neck" is applied to breaking over of

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Figure 6.—The long, narrow spots on these rice leaves are typical of the fungus-caused disease known as blast. At right, a normal leaf.

the head at the affected neck region. In addition the fungus attacks the nodes (joints) of the stem, with the result that they turn dark and the part of the stem above the point of attack is killed. Infection may appear also at the place where the leaf blade joins the sheath.

Blast has occurred in a scattered rather than a widespread way, and less frequently than the brown leaf spot. It has often been severe on newly cleared land and on land cropped to rice for the first time in several years. Perhaps this is explained by the fact that the soils of such areas are likely to contain much nitrogen, for rice is more susceptible to blast on soils having a high nitrogen content. High nitrogen fertilization should be avoided on rice soils of this kind.

Rain and warm weather favor development of blast. This is illustrated by the fact that outbreaks of blast in Louisiana in recent years have been confined to rice sown in June.

When young plants are attacked, development of the disease can be slowed down by flooding the field.

A variety that appears to be resistant to the blast fungus is sometimes found not to resist all its different races.

Narrow Brown Leaf Spot

Narrow brown leaf spot, sometimes known as cercospora leaf spot, is perhaps the most prevalent disease of rice in the Gulf States. This disease varies in severity from year to year. Generally it becomes more severe as the rice approaches maturity. The leaf spots are long and narrow (fig. 7) and of a light-brown or brown color. In severe cases the leaves die, one after another, until hardly any remain.

The infection does not become very severe until late August or September. Therefore, early maturing varieties tend to escape heavy infection if they are sown early.

Marked differences in susceptibility have been found among rice varieties. However, some of the different races of the fungus causing this disease may damage certain rice varieties that are resistant to other races. Because the prevalence of individual races varies from year to year in relation to that of other races, a rice variety may show resistance to narrow brown leaf spot in a certain place for several years and then succumb to it. Rexoro, Texas Patna, and Bluebonnet 50 are all susceptible. Century Patna 231, TP–49, Nato, and Improved Bluebonnet generally show some resistance.

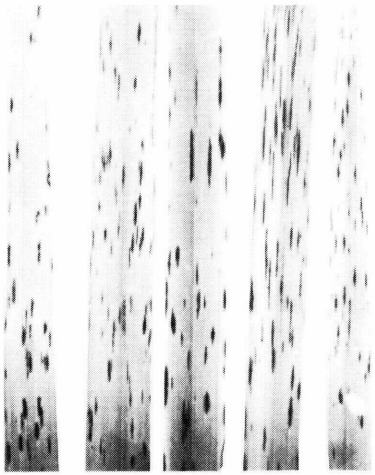

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Figure 7.—**Narrow brown leaf spot, perhaps the most prevalent disease of rice in the Gulf States.**

Stem Rot

Stem rot, caused by a fungus that lives in the soil, is one of the more important rice diseases in Arkansas and Louisiana and one of the less important in Texas. It has been found in California.

The first symptom is the appearance of irregular-shaped water-soaked areas on the sheaths, at or slightly above the waterline. Gradually these areas turn black and become larger, and in the course of time the infection enters the stalks. At this stage dark masses of fungus growth develop, together with black or dark-brown streaks along the stalk. At more advanced stages, splitting the stalk reveals a cottony grayish mold inside. Later, when the rice is generally approaching maturity, many small black seedlike bodies, called sclerotia, can be seen within split stalks (fig. 8) and in the rotting sheaths. At this stage the stalks break over and the plants lodge. Plants that are attacked early and killed before they mature produce lightweight grain or almost no grain. Lodging resulting from stem rot often makes harvesting difficult. (Not all lodging of rice is due to stem rot.)

The fungus causing stem rot often develops abundantly in rice stubble after harvest, even if little stem rot was present when the crop matured. The fungus lives in the soil and stubble in the form of sclerotia and may remain alive in the soil for 6 years. Certain wild grasses are susceptible to stem rot, and the infection may spread from them to rice.

None of the commercial varieties of rice are highly resistant to stem rot. Improved Bluebonnet and Rexoro are somewhat more susceptible than others. Because stem rot generally does not become prevalent until August or September, early maturing varieties tend to escape serious damage if sown early.

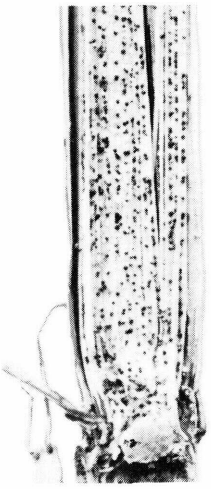

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Figure 8.—**Stem rot. Splitting of a rice stalk has revealed black fungus bodies inside. (About 3 times natural size.)**

Tests and observations made in Arkansas showed that application of potassium fertilizers to the soil reduced the severity of stem rot. Another control measure is to drain the water from the field at an early stage of sheath infection and keep the soil saturated, but not covered, with water until the rice has almost matured. Although the fungus can live in the soil for several years, crop rotations undoubtedly have considerable value for controlling it.

Use of fertilizers containing nitrogen makes the plants more susceptible.

Root Rot

Root rot, as discussed here, includes several diseases or dis-

orders in which the roots of young rice plants become deformed and discolored, then decay (fig. 9). As root decay progresses, the leaves cease to grow normally and turn yellow. The affected plants may die at any stage of growth.

Root rot may be caused by any one of several fungi. Rice roots may be damaged, also, by the feeding of nematodes and of root maggots. Plants growing in saline or alkali spots generally are affected with root rot and as a result grow poorly.

Treating the soil with chemicals that kill the fungi and nematodes has increased rice yields considerably in tests made in Texas and Louisiana. None of the chemical soil treatments tested are recommended to rice growers at the time of publication of this bulletin, however, because of their high cost. Treating rice seed with chemicals as described under the heading "Seedling Blight" may prevent root rot and decay at the bases of the stems of young plants. Top-dressing a rice field with fertilizer containing nitrogen and phosphate reduces root rot and improves yields in alkali spots.

Losses from root disorders can be held to a minimum through fertilizing and cultural methods that serve to maintain rice plants in a vigorous condition. A good way to stimulate new root growth and control root maggots is to drain the field and let the soil dry.

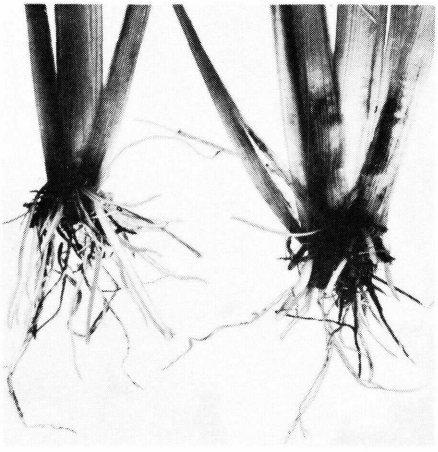

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Figure 9.—Root rot.

Minor Rice Diseases

Bordered Sheath Spot

Bordered sheath spot, caused by a fungus, is a minor rice disease frequently found in Louisiana and Texas. Large spots (fig. 10) appear on the sheaths just above the waterline and occasionally on the lower leaves. The spots have irregular

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Figure 10.—Bordered sheath spot.

outlines and reddish-brown borders. Generally the disease is observed on only a low percentage of the rice plants in a field and in only a limited part of the field. It is favored by warm, moist weather. Generally the plants attacked are in thick stands that retain moisture a large part of the day and are in the late tillering stage. Only slight losses result, because the few plants affected are not often damaged severely. Various wild grasses growing in mixture with rice may serve as sources of the infection. No control measures are known or warranted.

Leaf Smut

Leaf smut is a minor fungus disease of rice in which small, slightly raised black spots, called sori, develop on the leaves (fig. 11) and, to a lesser extent, on the sheaths and stalks. These spots contain the black spores of the smut fungus. Often infection is heavy enough to kill the tips of the leaves. When the spores have matured, the sori break open and liberate them. Leaf smut appears rather late in August or in September. No control measures are warranted.

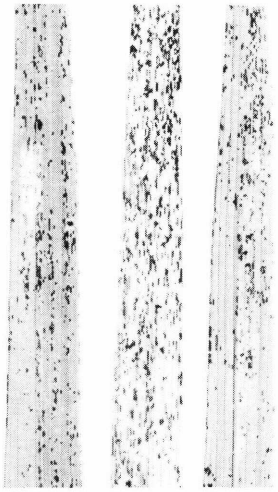

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Figure 11.—Leaf smut.

Kernel Smut

Kernel smut, another fungus disease of rice that has caused minor losses in the South, can be detected only on heads that have almost matured. At that stage a part or all of the starchy material of each affected kernel has been replaced by a black mass of smut spores. Release of some of the smut spores from within causes discoloration of the hulls (fig. 12). Generally, only 2 to 8 smutted kernels are found on a head.

The smut is detected most easily after rain or in early morning after a heavy dew. Moisture causes the dark mass of spores to swell and break out between or through the hulls. Spores that have not yet broken out can be seen through the wet hulls.

Kernel smut does not destroy the rice embryo, and the diseased seed generally germinates even if all the endosperm has been replaced by smut spores.

Because the life history of the kernel smut fungus is not fully understood, no control suggestions can be given. Varieties of rice seem to differ in susceptibility, but reliable information on resistance is lacking. Early sown varieties generally show little or no smut. Apparently the most susceptible of the present varieties are Sunbonnet, Toro, Bluebonnet, Bluebonnet 50, and Rexoro.

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Figure 12.—**Kernel smut. Release of smut spores from affected kernels discolors the hulls.**

Kernel Spots

Several types of kernel spots are found on rice. Many fungi cause rice kernels to be spotted, stained, or otherwise imperfect. Generally the same fungi cause heavy spotting or discoloration of the hulls. Kernel spotting appears to increase in damp or rainy warm weather. Punctures of the developing kernel by the rice stink bug, plus growth of fungi in the injured areas, result in a type of kernel spot called pecky rice. The presence of spotted or stained kernels reduces the grade of rice. Also, kernels that are severely spotted and therefore chalky break into pieces in the milling process; thus, kernel spot reduces yield of head rice. At present no control method can be recommended.

Hoja Blanca

Hoja blanca, a rice disease caused by a virus that is spread by a plant hopper, has not been reported from any of the principal rice-producing States of this country but was found in Florida in 1957. Heavy losses have resulted from this disease in Cuba, Venezuela, and other countries of Latin America.

The first symptom of hoja blanca is appearance of one or more white stripes on a leaf blade, or whitening of an entire leaf blade, or mottling of a leaf in a typical mosaic pattern. The diseased plants do not make normal height growth. Their panicles (heads) fail to reach normal size and often remain partly inside the sheath. The hulls that enclose stamens and pistil turn brown and rapidly dry out. Often they become distorted. The flower parts are sterile or even absent. Because the diseased plant produces few seeds or none, its head remains upright instead of bending over at maturity.

Rice plants do not die as a result of hoja blanca. Normal tillers and diseased ones may be produced by the same plant. Often the second-crop tillers of an infected plant show no symptoms.

All the rice varieties now commonly grown in the Southern States are susceptible. Lacrosse, R–500, Colusa, Asahi, and a few other minor varieties are resistant.

TABLE 1.—*Rice diseases, the organisms that cause them, and control measures*

Disease	Causal organism	Control measures
Principal diseases:		
Blast	*Piricularia oryzae* Br. & Cav.	Resistant varieties, early seeding, flooding.
Brown leaf spot	*Helminthosporium oryzae* Van Breda de Haan.	Seed treatment, cultural practices.
Narrow brown leaf spot.	*Cercospora oryzae* Miyake	Resistant varieties, early maturing varieties.
Root rot	Various fungi including *Rhizoctonia solani* Kühn and species of *Pythium* and *Fusarium*. Nematodes including a *Meloidogyne* species, *Tylenchorhynchus martini* Fielding, and *Radopholus oryzae* (Van Breda de Haan) Thorne. Root maggots, *Lissorhoptrus simplex* Say.	Crop rotation, balanced fertilizing, other cultural practices, draining.
Seedling blight	Chiefly *Helminthosporium oryzae* Van Breda de Haan, species of *Pythium*, *Rhizoctonia solani* Kühn, species of *Fusarium*, *Sclerotium rolfsii* Sace.	Seed treatment, shallow seeding if seeding is done in early spring, flooding.
Stem rot	*Sclerotium oryzae* Catt.	Resistant varieties, balanced fertilizing, draining, crop rotation.
Straighthead		Resistant varieties, draining.
White tip	*Aphelenchoides besseyi* Christie (sometimes called *A. oryzae* Yokoo).	Resistant varieties, disease-free seed, water seeding and continuous flooding.
Minor diseases:		
Bordered sheath spot.	*Rhizoctonia oryzae* Ryker & Gooch.	None known or warranted.
Hoja blanca	[1]	Resistant varieties.
Kernel smut	*Neovossia barclayana* Brefeld.	None.
Kernel spots	Various fungi. Rice stink bug (*Oebalus pugnax* (F.)).	None except insect control.
Leaf smut	*Entyloma oryzae* H. & P. Sydow.	None.

[1] Hoja blanca is caused by a virus that is transmitted by a plant hopper, *Sogata orizicola* Muir.

TABLE 2.—*Disease resistance and susceptibility of common commercial rice varieties* [1]

Variety	C. I. No.	White tip	Straight-head	Brown leaf spot	Narrow brown leaf spot	Stem rot
Arkrose	8310	VS	S	S	S	MR
Asahi	8312	MR	MS	S	R	MR
Bluebonnet	8322	R	MR	S	S	S
Bluebonnet 50	8990	R	MR	S	S	S
Blue Rose (Improved)	2128	S	S	MS	VS	MR
Caloro	1561–1	S	MS	S	S	MR
Calrose	8988	S	MS	MS	MS	
Century Patna 231	8993	MR	S	MS	MS	S
Cody	8642	S	MS	S	MS	S
Colusa	1600	S	S	MS	S	
Early Prolific	5883	VS	S	MS	VS	S
Fortuna	1344	R	MR	MS	S	S
Fortuna, Arkansas	8309	R	MR	S	S	S
Improved Bluebonnet	8992	R	S	S	MR	VS
Kamrose	8314	S	MS	MS	R	MR
Lacrosse	8985	S	MR	S	MS	
Magnolia	8318	S	S	MS	S	MR
Nato	8998	MS	MS	MS	MS	
Nira	2702	R	S	MS	S	VS
Prelude	8311	S	MR	MS	S	S
Rexark	8644	MR	S	MS	S	S
Rexoro	1779	R	VS	S	VS	VS
Sunbonnet	8989	R	VS	S	S	S
Texas Patna	8321	R	R	S	VS	S
Toro	9013	R	MR	MS	S	
TP–49	8991	R	VS	S	MS	
Zenith	7787	S	S	MS	S	MR

[1] Key to symbols: R=resistant; MR=moderately resistant; MS=moderately susceptible; S=susceptible; VS=very susceptible.

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